Environment and Ecology 37 (1B) : 452—457, January—March, 2019
Website: environmentandecology.com ISSN 0970-0420

Influence of Temperature as an Environmental Factor on the Distribution of Biodiversity in Nallamala Forest (Kurnool District), Andhra Pradesh

Nagabhushan Reddy M., Sai Indrani G., Amrutha Valli S., Shanthi Priya K.

Received 7 November 2018; Accepted 11 December 2018; Published on 7 January 2019

Abstract Environment is a combination of all the nature's gifts without even the trace of human contribution to it. The process of development without integrating the environmental concern has generated the risk of very delicate and slow but of very sensitive nature in the form of by-product that the whole world feels as a climate change. Climate change ordinarily indicates change in behavior of the weather elements over an area during a time span. One aspect of this complexity is that climate changes will impact unevenly across the ecosystems that prove vulnerable to climate changes. Biodiversity means variation of life forms within a given ecosystem. The present works done affempts to trace down the nature of inter-relationship between the climate change and biodiversity (faunal) especially with regard to temperature variations in Nallamala forest (Kurnool District) of Andhra Pradesh. Temperature is one of the limiting factors of the species expansion that determines its distribution in boundaries of the area. Tolerance to temperature for highly developed organisms is much lower within the interval from 0 to + 50 ^{0}C.

Keywords Biodiversity, Temperature, Nallamala forest, Climate change, Kurnool.

Nagabhushan Reddy M.,* Sai Indrani G., Amrutha Valli S., Shanthi Priya K.
Department of Zoology, Rayalaseema University, Kurnool 518002 (AP), India
e-mail: mnabhushr@gmail.com

*Corresponding author : M. Nagabhushan Reddy
Assistant Professor (MTS)
Department of Zoology,
Rayalaseema University,
Kurnool 518002 (AP), India

Introduction

Environment is essential for the human survival in various forms without which no one can think of his existence. In course of time, man's desire, propensity and capability to race for the development resulted in a threshold situation beyond that if suitable and careful management was not undertaken, the environment would not be worth-living. Such a critical state of affairs led to cause environmental problems of the second generation, known as global warming, greenhouse gas effect/climate change, ozone layer depletion, acid rains, sea level rising and loss of biological diversity on the planet. The process of development without integrating the environmental concern has generated the risk of very delicate and slow but of very sensitive nature in the form of by-product that the whole world feels as a climate change.

One aspect of this complexity is that climate changes will impact unevenly across the ecosystems

that prove vulnerable to climate changes (Edward 2006). It affects the physical condition of the environment as well as representatives of the ecosystem in various forms and contents. Article 1.1 UN Framework on Climate Change defines Adverse effects of climate change as meaning changes in the physical environment or biota resulting from climate changes which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystem or on the operation of socio-economic systems or on human health and welfare. One of the components of the natural ecosystem is biological diversity that is also threatened due to the climate change. Biodiversity is the variation of life forms within a given ecosystem. Most of the biodiversity of the earth is located around equator due to its high temperature and rainfall. It is a parameter for the health of environment. It is the outcome of over 3.5 billion years of evolutionary development shaped by the natural processes. Greater biodiversity implies better health.

In 1999, Ministry of Environment and Forests prepared a National Policy and Macro level Action Strategy on Biodiversity needed for conservation and sustainable use of biological diversity. India has a rich and varied heritage of biodiversity, encompassing a wide spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forests to coastal wetlands. Hotspots are regions that harbor a great diversity of endemic species and at the same time have been significantly impacted and altered by human activities. Among the 25 hotspots of the world, 2 are located in India extending into neighboring countries the Indo-Burma region (covering the Eastern Himalayas) and the Western Ghats /Sri Lanka. These areas are paricularly rich in floral wealth and endemism, not only in flowering plants but also in reptiles, amphibians, swallow tailed butterflies and some mammals.

The linkages between climate change and biodiversity being very fragile can only be maintained by taking precautionary measures through appropriate law and strict adherence there to in the process of assessment and mitigation, let it gets too late. The determination of the environmental factors is large problem and the data should be habits, habitat preference and analyses of the conditions in the habitat, exact range and the results of the experiments upon the effect of altering the intensities of environmental factors.

Experts also say the consequences of climate change would be in the shift in precipitation patterns and hydrological processes which influence the spatial and temporal distribution of runoff, soil moisture and groundwater reserves, and increase the frequency of droughts. Current anthropogenic climate change and the need to quantify its effects have brought to the fore the long-recognized role of global climate in driving change in taxonomic richness (Mayhew 2011).

It is important to review and modify relevant environmental policies and in parallel develop strict regulatory frameworks to ensure that environmental and social impacts are minimized and mitigated (Webb et al. 2012). Concomitantly, the results of the protected area gap analysis should be integrated with national land use plans to limit conflicting land uses and maximize connectivity across conservation corridors. With the economic opportunities presented by increasing number of development projects in the country there is a need to include valuation of environmental services and biodiversity in development planning.

Ecosystem services have emerged as an integrated framework for managing ecosystems in an increasingly human dominated world (Harris et al. 2006, Lele et al. 2013). Defined as the benefits natural systems provide to humans, this nature for people paradigm has been increasingly adopted by governments and nonprofit organizations to frame, plan and allocate resources (Posner et al. 2016). There is a notable division between those that see ecosystem function as something that can be quantified in monetary terms versus those that explicitly reject one dimensional valuation schema as being both impossible and undesirable (Pascual et al. 2017).

This research work is carried out to determine the influence of temperature on distribution of biodiversity especially in relation to fauna. Nallamala Hills stretching across 5 districts across portions of Kurnool, Prakasam, Nalgonda, Guntur and Kadapa

of the state of Andhra Pradesh is renowned for being rich in biodiversity (Rao 1998). Nallamala ($15^0 20'$-$16^0 31'$ N and $78^0 30'$-$80^0 10'$ E) is a group of low hill ranges in the central part of Eastern Ghats. From the Plnad basin in the nortg to the Tirupati basin in the south, the Nallamala runs a distance of 430 km with an average width of 30 km (Anon 1965). The altitude ranges from 200 to 950 m. An unbroken chain of rugged hills with precipitous cliffs encompassing an area of about 7640 km^2 forms the range. The humus content is almost negligible as the black soil occurs in plains where cultivation is practiced (Krishnan 1956). The vegetation is typically of southern tropical dry deciduous and southern tropical moist deciduous forest types intermingled with shrub (Champion and Seth 1968). The climate is generally hot and dry with temperatures rising up to 43^0C to 45^0C during May and dips down to 8^0C in December.

Though sveral research activities and surveys were made in the area of study i.e. Nallamala forest (Kurnool District) of Andhra Pradesh regarding the characterization, quantification of the species diversity; the study of distribution of the species of flora and fauna (biodiversity) with regard to temperature changes is required unmost importance. Hence this work is selected.

Materials and Methods

Direct method involving sampling area i.e. as mentioned above (Nallamala forest,Kurnool District, Andhra Pradesh) by observing and recording the changes in temperature further which quantification of biodiversity (faunal) has also been done and also based on secondary data.

Results and Discussion

The present work done attempts to trace down the nature of inter-relationship between the climate change and biodiversity (faunal) especially with regard to temperature variations in Nallamala forest (Karnool District) of Andhra Pradesh.

The Western Ghats is home to a rich variety of flora and fauna. The Sahyadri also has 330 varieties of butterflies (11% endemic), 156 species of reptiles (62% endemic), 508 types of birds (4% endemic), 120 species of mammals (12% endemic), 289 varieties of fish (41% endemic) and 135 species of amphibians (75% endemic). Nallamala forest supports a wide variety of animals, birds, insects, reptiles and amphibians (Murthy 1968, Agrawal and Bhattacharya 1976). The reserve is home to many charismatic animals like Tiger, Leopard, Sloth Bear, Wild dog, Jackal, Ratel, Porcupine, Giant squirrel, Mouse deer, Four horned antelope, Sambar, Spotted deer, Nilgai and Wild boar (Table 1).

Table 1. Biodiversity (faunal species) found in Nallamala forest (Kurnool District) of Andhra Pradesh.

Sl. No.	Group	Number of species in Nallamala forest (2017-18)	% Loss/% Increase in species (Approx)	% Loss/% Increase in no. (Approx)
1.	Mammals	50	± 1-2	± 20-30
2.	Birds (Aves)	200`	± 4-5	± 25-35
3.	Reptiles	54	± 1-2	± 10-20
4.	Amphibians	18	± 0-1	± 40-50
5.	Fishes	55	± 0-1	-
6.	Butterflies	89	-	-
7.	Moths	57	-	-
8.	Coleopteran insects (Beetles)	45	-	-

Animals are found to occupy all diverse habitats wherever life is possible but the animals found in different regions, different areas and different localities are not identical. These exhibit several complications in their distribution pattern. The factors which control or check migration and dispersal of animals are known as barriers i.e. Geographical regions like Palearctic region, Nearctic region, Neotropical region, Ethiopian region, Oriental region and Australian region which of course classified on the basis of the environmental factors existing in that areas.

Environmental factors influence living organisms by determining their spatial distribution, number and species composition at the certain area. Response of living organisms on each individuals environmental factor is described by a diagram of Shelford's theoretical model (Fig. 1).

As numberical values of organism's response a variety of processes of living organisms and charac-

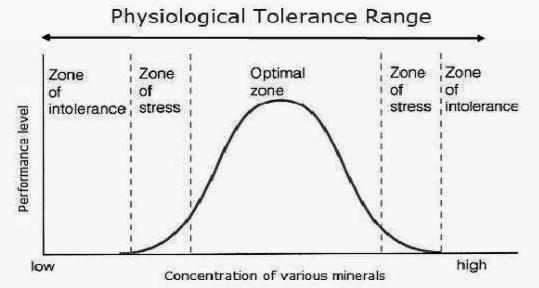

Fig. 1. Physiological tolerance range of organisms.

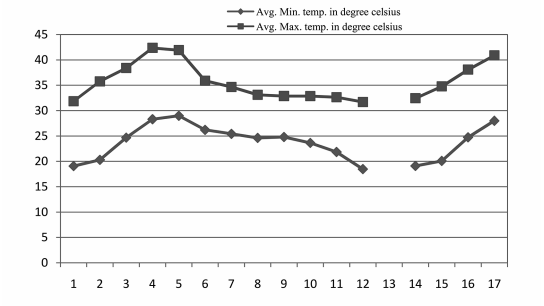

Fig. 2. Temperature recordings of Nallamala Forest (Kurnool District) of Andhra Pradesh for the year 2017-18. On X-axis, 1,2,3,4,5,6,7,8, 9,10,11,12 denotes for the months of January to December, 2017; 14,15,16 and 17 denotes for the months of January to April, 2018. On Y-axis, temperature in degree celsius.

terizing properties can be used, for example: Mobility, Number of organisms, Intensity of Metabolism and Intensity of Reproduction. But as values characterizing factor's performance, intensity of a factor is used. Interaction of factors becomes apparent in the way that at the influence of one factor at the same intensity the reaction of an organism is different, depending on exposure intensity of other factors.

Assessing the impact of climate change on species, particularly important is impact of 2 environmental factors – temperature and humidity (#rainfall). If the ambient temperature is below or above a certain critical threshold, an organism is unable to provide the life processes and dies either from overheating or freezing. Tolerance to temperature for highly developed organisms is much lower – within the interval from 0 to + 50^{0}C. Tolerance intervals of primitive organisms (bacteria and fungi) are generally significantly larger than those for developed organisms. Spores of fungi remain viable even at temperatures close to absolute zero (-273^{0}C) or considerably higher than the boiling point of water (+100^{0}C). Insects and mites are the groups of organisms that can be affected the most of all by climate change due to their rapid reproduction, short development periods and high sensitivity to changes of temperature and humidity.

The variations in the temperature have been recorded for the months of January, February, March and until April 2nd 2018 and for the year 2017 (from January to December) at the selected area i.e. Nallamala forest (Kurnool District), Andhra Pradesh (Fig. 2).

Temperature is one of the limiting factors of the species expansion besides humidity (moisture) that determines its distribution in boundaries of the area. Adaptation of species to climate change in the past took place mostly by shifting of their distribution boundaries to higher or lower latitude, or up and down the mountain slopes, depending on whether the climate became warmer or colder. If the temperature will increase by 4.1^{0}C, the expected outcome is even more dramatic – distribution area for 229 species will decrease by 50% and for 70 species by 95%, which in practice means that they will be on the brink of extinction (Waldock et al. 2018). Assuming that until 2080 the average temperature will increase by 2.4^{0}C, distribution area for 140 species will decrease by more than 50% and for 9 species by more than 95%.

It is evident from the data of temperature variations from 2017-2018 (Table 1 and Fig. 2) there is marked increase /decrease with regard to different seasons which is quite natural, the adaptability of the different species of biodiversity (faunal) is expected healthy (with in the biokinetic zone) with respect to poikilotherms and homeotherms accordingly. Hence, there is little significant deviation with regard to no. of the species diversity and species richness.

Approximately 20-30% of plants and animals assessed so far are feared to be at the risk of extinction if increase in global average temperature exceeds 1.5

to 2.5^{0}C (IPCC 2007). The impact of climate change is multiple and long term process like sea level rise, temperature increase, forcing the changes in biodiversity and the basis capabilities of the future generation. It is a complex network of changes before the world. Therefore, protection of the biodiversity assumes very significant place in the study of climate change. Maintaining biodiversity and associated ecosystem's functions is an important component of adaptation to climate change (Ahmed 2010). Loss of biodiversity and its potential damage in *inter alia* one impact of climate change (CBD 2010).

One analysis of compendia of fossil taxa suggests that biodiversity declines with increasing global temperatures (Mayhew et al. 2008) but the focus on temperature as the driver, without reference to other variables, has drawn criticism. Ecologists are also worried about temperature variation in the Western Ghats. Even a little shift in temperatures in the Ghats may wipe out a veriety of fauna including those that are yet to be discovered. Studies have revealed alterations in the hydrological cycle, which affects the availability and quantity of freshwater and has become a serious issue in the 21st century. The gloomy status is evident from the decline of dense forests with native species in the northern, central and southern Western Ghats by 2.84%, 4.38% and 5.77%, respectively.

Physiologists have shown clearly that while temperature is an important physiological agent there are many other agents any one of which may be unfavorable at certain intensities. In other words, each environmental factor has an optimum intensity and unfavorably affects the animal at intensities either above or below the optimum. The conception of the nature of environmental relation together with the physiological diversity of animals negatives the expectation that any one factor will ever be for the present distribution of a fauna. The apparent zones become in reality only the habitats of a limited number of forms. It is possible that changes in temperature and moisture either directly or through effects on the flora, are the factors which the environments sufficiently to control the north-west distribution of forms on great continents like but this remains to be proved (Mayhew et al. 2012),

Hence, we conclude that further investigation is necessary in this regard with respect to physiological, behavioral aspects of the Biodiversity (faunal) in response to the said temperature influence on their distribution in this said Nallamala forest, Kurnool District of Andhra Pradesh.

References

Agrawal VC, Bhattacharya TP (1976) Report on a collection of mammals from Nagarjunasagar, Andhra Pradesh. News Let Zoo Sur Ind 2 (5) : 212—216.

Ahmed Djoghlaf, Executive Secretary, CBD (2010) http://www.iisd.ca/climate-1/bulletin.

Anon (1965) The Gazette of India – Indian Union. Country and People. Publications Division, Govt. of India, New Delhi, Vol. I.

CBD (2010) Conference of the parties (10th meeting). Nagoya, Japan, 18th-29th October.

Champion HG, Seth SK (1968) A revised survey of forest types of India. Govt. of India, New Delhi.

Edward A (2006) Climate Change: Justice and Future Generations, pp 37.

Harris JA, Hobbs RJ, Higgs E, Aronson J (2006) Ecological restoration and global climate change. Restrn Ecol 14 (2) : 170—176.

IPCC 4th Assessment Report (2007) http://www.global-green-greenhouse-warming.com.

Krishnan (1956) Geology of India and Burma. Madras, Government of India.

Lele S, Springate-Baginski O, Lakerveld R, Deb D, Dash P (2013) Ecosystem services: Origins, contributions, pit falls and alternatives. Cons Soc 11 (4) : 343.

Mayhew PJ (2011) In : Hodkinson T, Jones M, Waldren S, Parnell J (eds). Climate Change, Ecology and Systematics. Cambridge, UK, Cambridge Univ. Press, pp 99—121.

Mayhew PJ, Bell MA, Benton TG, McGowan AJ (2012) Biodiversity tracks temperature over time. Proc Nat Acad Sci 109 (38) : 15141—15145.

Mayhew PJ, Jenkins GB, Benton TG (2008) A long-term association between global temperature and biodiversity, origination and extinction in the fossil record. Proc Biol Sci 275 : 47—53.

Murthy TSN (1968) Notes on the collection of amphibians from Nagarjuna Valley (Andhra Pradesh) with one new record. J Univ Poona 34 : 63—71.

Pascual U, Balvanera P, Diaz S, Pataki G, Roth E, Stenseke M, Watson RT, Dessane EB, Islar M, Kelemen E, Maris V (2017) Valuing nature's contributions to people : The IPBES approach. Curr Opn Environ Sustn 26 : 7—16.

Posner SM, McKenzie E, Ricketts TH (2016) Policy impacts of ecosystem services knowledge. Proc of Nat Acad of Sci, United States of America, USA 113 (7) : 1760—1765.

Rao RK (1998) Nallamalai Hills : Among world centers of plant diversity. In : The Eastern Ghats. Proc of the Nat Sem on

Conserv of Eastern Ghats, March 23-26, pp 317—321.
Waldock C, Dornelas M, Bates AE (2018) Temperature-driven biodiversity change : Disentangling space and time. Biosci 68 (11) : 873—884.
Webb EL, Phelps J, Friess DA, Rao M, Ziegler AD (2012) Environment-friendly reform. Myanmar Sci 336 : 295.